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ABSTRACT

This document is the report of a study designed to determine the economic effects of quality education on college graduates. In order to do this, a sample of World War II veterans was surveyed as to their incomes after college. A regression analysis was used to study the relationship between college quality and individuals' incomes, controlling for individual ability, years in school, experience, and other socio-economic traits. Both peer group effects and faculty quality were found to be significant influences on later incomes of students. The influence of quality grew as labor force experience grew. Educational quality seemed to have greater effects for more able students. Also additional years in school are substitutes for college quality in the process of preparing to earn income in post-school life. (Author/HS)

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FINAL REPORT

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THE DEFINITION AND IMPACT OF COLLEGE QUALITY

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ABSTRACT

This research has studied a sample of World War II veterans in order to define college quality and measure its impact in terms of contribution to subsequent incomes of those who attended. Regression analysis was used to study the relationship between college quality and individuals' incomes, controlling for individual ability, years in school, experience, and other socio-economic traits.

Both peer group effects and faculty quality were found to be significant influences on later incomes of students. The influence of quality grew as labor force experience grew. Quality seemed to have greater affects for more able students. Also additional years in school are substitutes for college quality in the process of preparing to earn income in post-school life.

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PREFACE

The research reported herein was performed pursuant to a grant from the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy. Moreover, this research has not undergone the review procedures of the National Bureau of Economic Research.

I would like to acknowledge the very helpful comments of Mary Jean Bowman, Barry Chiswick, F. Thomas Juster, William Landes, Paul Taubman, Paul Wachtel, and Finis Welch. Research assistance was performed by Joanne Gallo, Gail Morris and Susan Tebbetts. My secretary, Catherine Grant did an excellent job of typing several drafts. Of course remaining errors are the responsibility of the author.

This work will contribute to a larger and more detailed study of returns to educational quality now underway at the National Bureau of Economic Research, funded by the Office of Education. Many of the suggestions for further work made herein will be carried out under the larger grant.

THE DEFINITION AND IMPACT OF COLLEGE QUALITY

Lewis C. Solmon

I. Introduction

Many people have opinions on which colleges are of good quality and which are poor; the bases of these judgments can range from the number of Nobel Laureates on the faculty to the national ranking of the football team. A more systematic analysis of quality would try to identify the features of colleges which enable those whom the colleges are serving (students, alumni, taxpayers or society as a whole) to best achieve their goals. Here we are concerned with the characteristics of colleges which serve to increase subsequent monetary incomes of those who attend.

Usually, lifetime earnings are explained by variables such as innate ability, experience in the labor force, and years of education, although other socio-economic, demographic and occupational data can be inserted to increase the explanatory power of the model. This paper attempts to add a new dimension to the earnings function analysis by hypothesizing the features of colleges which might yield financial payoffs in later life, and then testing to see which of these traits actually do add most to the explanatory power of the traditional earnings function. Several methods of identifying the mechanism by which these quality traits affect income will be tested, including rates of return to quality estimates and tests for the interaction of school quality with individual ability and with years of schooling, and also interactions among the various quality traits.

Two general types of attributes of colleges can be isolated and measured (if imperfectly). They are as follows:

1. Student Quality. The argument is that a student benefits more from college, and hence acquires more of whatever colleges give that enhances future earning power, when surrounded by high quality fellow students. This has been called the peer effect. Intuitively, it does seem that the opportunity to interact with intelligent and motivated peers should enrich the college experience. We have several measures of average student quality by schools: the average Scholastic Aptitude Test (S.A.T.) scores of entering freshmen,[1] and an index of intellectuality of students obtained by Alexander Astin through factor analysis.[2]

Another variable which has been developed by Astin, an index of selectivity based upon the proportion of applications rejected, is also used as a dimension of quality. It can be argued that this may be a poor measure since a college which randomly selects a given proportion of applications may have a higher rejection rate than one whose minimum quality standard is posted and no one below this level applies. However,

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1 Of course an individual's IQ will be highly correlated with his S.A.T. scores. However, here we are looking at the effect of average S.A.T.'s of all students at a college on an individual's subsequent income, controlling for the individual's IQ.

2 J. Cass and M. Birnbaum, Comparative Guide of American Colleges, Harper and Row, 1969 gives SAT scores; A. Astin, Who Goes Where to College? Science Research Associates, 1965 gives the intellectuality and selectivity indices.

evidence below suggests that higher rejection rates probably mean a larger number of students in the lower tail of the "student quality" distribution are denied admission.

2. Instructional Quality. The second aspect of college quality is the excellence of faculty. They hypothesis here is that better faculty instill in students traits which will be beneficial in subsequent years. One measure of faculty quality is average faculty salary.[3] The assumption is that higher paid faculty have either more experience (and higher rank), better teaching ability, more professional prestige from research, or greater opportunities to earn elsewhere; all of these being indicators of greater productivity in their professorial roles.[4] Another measure of school quality is school expenditure for instruction, research and library per full-time equivalent student. Here, the argument is that high quality faculty are attracted by expenditures beyond those on salaries alone. Also, holding these expenditures per faculty member constant, a larger expenditure per students implies a greater teacher/ student ratio.[5] Thus, this measure is a test of the influence of

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3 AAUP, "The Economic Status of the Profession," AAUP Bulletin, Summer, 1964 Data are for 1963-64.

4 One might ask about the relationship between these traits and academic salaries; and also which of these have more important affects on students' later incomes. However, data limitations enable us here only to look at the gross relationship between faculty salaries and student incomes.

5 This is true if we assume contact hours per faculty member are constant. Obviously: $\frac{\text{Exp.}}{\text{Stu.}} = \frac{(\text{Exp})}{(\text{Fac})} \times \frac{(\text{Fac.})}{(\text{Contact Hrs.})} \times \frac{(\text{Contact Hrs.})}{(\text{Student.})}$

teacher/student ratios as well. The hypothesis is that the first derivatives of both expenditures per faculty member and faculty per student with respect to quality are positive.[6] Unfortunately, data of this kind ignore differing definitions of "full-time faculty" at different colleges. Teaching loads range from one course to four or more per semester at different colleges and these differences may alter teacher effectiveness. Other problems with this proxy for quality arise since it allows for no nonpecuniary attractiveness of particular colleges for particular faculty members. Schools located in undesirable areas (urban ghettos with high crime rates or isolated rural areas with no cultural life) may be forced to pay high salaries for even mediocre quality faculty. Schools with attractive surroundings (scenery, a few top scholars, cultural life or exceptionally good research and teaching equipment and plant) may be able to attract high quality faculty for low salaries. Low salaries may be paid to top quality faculty where opportunities for lucrative outside consulting jobs abound. Of course, students may or may not get benefit from "good" faculty who are away consulting much of the time. In any case, the hypothesis we will test is that schools which pay large salaries to faculty members who meet relatively small groups of students are more beneficial to student's subsequent earning power than those schools which pay low salaries or have large classes.

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6 Quality can be thought of as attributes of colleges which increase learning which, in turn, makes students able to earn larger incomes in later life.

A related quality measure refers to the total incomes or expenditures per student of the colleges. It might be argued that schools which spend (or receive) larger amounts per enrollee provide a higher quality education, an educational experience more beneficial in post-school years.

As an additional test of school quality we have a subjective measure made by Gourman. These ratings propose to be a "consensus of reliable opinion and judgment obtained from many and various sources deemed to be dependable and accurate." The study evaluates individual departments as well as administration, faculty, student services and other general areas such as library facilities. An average of all items is calculated, resulting in an overall Gourman Index between 200 and 800. The interpretation of these ratings depends upon the weights given to the various criteria. Unfortunately, these weights are not published. However, the index is one of the few quantitative ratings of a large number of colleges.

II. The Theoretical Framework

At this point it is interesting to see how the current study fits in to work to date on the human capital earnings function.[7] The general form of the earnings function explicated by Mincer is

$$Y_t = Y_o + rC + u \tag{1}$$

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[7] Jacob Mincer,

where Y_t is current earnings, Y_o is earnings obtainable without any investment in human capital, and C is investments in human capital (measured in dollars) up to that point in the individual's life. In this model, r, the coefficient on C is the rate of return to human capital investments. Mincer has shown that (1) can be converted into a form more estimatable with available data represented by (2)

$$\ln Y_t = \ln Y_o + rH + u \tag{2}$$

where H is the individual's current stock of human capital measured in time equivalents. In this case r is the rate of return to human capital only if we assume that student earnings exactly equal direct educational costs.[8] This is important due to the unique nature of our sample and is discussed below.

We can define a production function for human capital as

$$H = f\ (R,\ T,\ B) \tag{3}$$

where R is the rate of input of market resources, T is the rate of input of the investor's time per unit calendar time, and B is the individual's

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[8] The coefficient on H (i.e., r) equals k times the rate of return where $k = \dfrac{\text{Actual Opportunity Costs plus Direct Costs}}{\text{Annualized Opportunity Costs}}$. If direct costs equal student earnings the numerator equals opportunity costs adjusted for twelve months.

physical and mental powers.[9] Here we are interested in the relationship between human capital production and the earnings function, and this relationship can be studied by substituting (3) into (2), to get

$$\ln Y_t = \ln Y_o + r.\ f\ (R,\ T,\ B) + u \tag{4}$$

Equation (3) is the human capital earnings function in the case where only the demand for human capital shifts but the supply curve is identical for all individuals. That is, H is determined only by shift factors in the demand curve if the supply curve is the same for all individuals.[10]

The level of the demand curve in turn will depend in part upon the specific inputs which go into an individual's human capital production function. Here we seek to determine the extent to which factors in the human capital production function influence subsequent earnings of the individuals doing the investing.

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9 See Gary Becker's Woytinsky Lecture for a more detailed analysis.

10 In this case if r and H are correlated positively the supply curve is upward rising. In essence, we are accepting Becker's "elite" approach in which it is assumed that everyone more or less has effectively equal opportunities. It assumes that everyone has equal access to funds in the capital markets, since the supply curve describes the marginal costs of financing human capital. With loans to finance college education becoming more pervasive, this "elite" model might not be too far from the truth. The empirical work in this paper uses a sample of World War II veterans, all of whom went to college under the G.I. Bill. Hence the equal opportunity assumption is even more realistic here. As we shall see later, the subsistence payments provided by the G.I. Bill lead us to interpret r as not being the rate of return to human capital investments.

For the empirical specification of (3), B is measured by IQ, T by years of schooling obtained, and R, market or purchasable inputs, by the quality measures suggested above. The quality measures represent features of the educational institutions which are costly. We can calculate rates of return to various types of investment in higher quality schooling. Empirically, we want regressions to determine the relationship between earnings and these attributes of colleges, controlling for other inputs into the human capital production function, namely time and ability.

To determine the effect of the various dimensions of college quality upon earnings of those who attended, earnings functions were estimated of the form:

$$\ln Y = a + b\ YRS + c\ EXP + EXPSQ + e\ IQ + f\ QUAL \qquad (5)$$

where ln Y is log of 1969 earnings, YRS is years of education, EXP is years of experience in the full-time labor force (years since first job) EXPSQ is the squared value of EXP to take account of the nonlinear influence of on-the-job experience on earnings, IQ is a measure of the level of ability (presumably affected by a combination of genetics and environment) and QUAL is the quality measure for the <u>last</u> college attended by the respondent. This particular form of the quality variable was selected since it appeared in preliminary work that those who went to more than one college (for example, graduate school) had incomes affected primarily by the nature of their final college.

For those with thirteen or more years of schooling the following equation was estimated:

$$\ln Y_{69} = a + b\, Q_{UG} + cZ.Q_{UG} + d\, Q_{GRAD} + e_i V_i + u, \qquad (6)$$

where Z = 1 if years of education was 13 to 16 inclusive and 0 otherwise, Q_{UG} and Q_{GRAD} are measures of undergraduate and graduate college quality, respectively and V_i are other variables like ability, years of education, experience, and several occupational dummies. The occupational dummies were particularly necessary since teachers are traditionally paid less than other people with the same education and doctors receive more. With this formulation the coefficients c and d were significant (t-tests) but b was not. The implication is that undergraduate quality matters only for those who do not go beyond four years of college.

A single variable, quality of the last college, was devised as the Q_{UG} for those not going on, and Q_{GRAD} for those with more than four years of college. This enables a single "rate of return" to college quality and ignores different payoffs to quality depending upon years. Evidence will be presented that returns to quality of last college may differ for those with 16 or less years of education compared to those with graduate work. There is also evidence that people with different ability should be studied separately. However, for simplicity, and to assure sufficiently large sample sizes, most of the detailed analysis here is carried out using a single "Quality last" specification.

III. Empirical Estimates of Earnings Functions With Quality Variables

The data used are the NBER-Thorndike sample which has been described in detail in several other places.[11] The respondents were white World War II veterans, all of whom took a battery of aptitude tests in 1942 to determine if they were qualified to be pilots.[12] To take the test, one had to have above average IQ and be in good health. Those willing were surveyed by Thorndike in 1955 and by the National Bureau of Economic Research again in 1969. They provided much information on earnings history, socio-economic situation, and educational experience including name(s) of college(s) attended, as well as aptitude test scores. Each college was given a code number and various quality measures of an individual's school(s) were entered on the tape as data associated with that person. For purposes of the current work, individual's were included in the regressions only if they attended colleges for which all the quality measures were available. This was done so that comparisons between different quality measures in the regressions would not be clouded by varying degrees of freedom. (We would have to eliminate individuals in particular regressions when the quality measure was not available for their schools, or the computer would assign a value of zero to quality which is wrong.) There were 1,511 people in this sample.

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11 Taubman and Wales.

12 The IQ variable used is a combination constructed by factor analysis of several of the AFQT tests and has a mean of .30 and a standard deviation of 1.86.

The question arises whether this biases the study due to the particular types of schools remaining for which all the quality data are available. Biases would exist if one particular quality of school refused information. At first glance, one might predict that schools of low quality would be the ones reluctant to report. However this is not generally true. Many schools provide the services of granting college educations and degrees to high school graduates who are not qualified to enter schools generally considered to be high quality institutions. It is in the interest of these low quality schools to become known by less qualified college aspirants. On the other hand, a number of schools with "good reputations" may be reluctant to report statistics for fear of revealing quantitative evidence that their reputations may not be fully justified. Hence there appear to be reasons why both high and low quality schools would not report. Some schools may have other reasons, unrelated to quality, for not reporting. For example, some schools only require S.A.T. scores from lower quality applicants (those graduating in the bottom 75 per cent of their high school classes must report S.A.T. but not those in the top 25 per cent). Some schools might not feel that their available data are relevant, as when most faculty members are only part-time employees of the college. Other schools might not want to take the time to compute the data desired. There is no reason why these non-reporters should fall into any particular quality group, and the evidence confirms this.[13]

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13 The colleges remaining in our sample range from the very top to the very bottom of each of the quality measures. However, the 1,511 individuals left for our study appear to have somewhat higher incomes, years of schooling and ability than the full sample with thirteen or more years.

A potentially more serious problem with the quality data is that most of the information on schools is for the post-1960 period, whereas the respondents attended around 1950. Unfortunately, earlier data on colleges are not available; schools have been willing and able to use computers to make information available only in recent times. The assumption is that the correlation of college quality is unchanged over time. This assumption is probably not too bad particularly in a gross sense (good schools are still good but the ranking of the good schools might vary somewhat). We can view the differences over time as a random measurement error.

The only data available over a reasonable period of time are those on average salary. Data for 36 schools were made available to me for the years 1939-40, 1953-54, 1959-60 and 1969-70.[14]

Several tests were performed and these revealed significant serial rank correlation. Analysis of variance revealed that the variation of rank across schools was significantly greater than the variance of rank of a school over time.[15] Table 1 reveals the Spearman Rank Correlation Coefficients and tests of significance for values of average salary in

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14 These were obtained through the generous cooperation of Mrs. M. Eymonerie of the American Association of University Professors, Washington, D.C. The thirty-six schools were not identified specifically but represent a cross-section of American colleges.

15 The F-ratio was 12.43 and the critical F for the given degrees of freedom for significance at the 1 per cent level is 1.99.

TABLE 1

Tests of Serial Correlation of Average Faculty Salary

Years Compared	Spearman Rank Correlation Coefficient	Significance (26 DF)
1939-40 and 1953-54	.6759	4.6772
1939-40 and 1959-60	.8100	7.0447
1939-40 and 1969-70	.5500	3.3586
1953-54 and 1959-60	.8752	9.2251
1953-54 and 1969-70	.7099	5.1396
1959-60 and 1969-70	.7777	6.3097

particular years. Both tests indicate a strong tendency for schools to be of roughly the same rank quality over time.

It will be shown below that the quality measures for later periods are highly correlated with earnings of those who attended earlier. One is tempted to argue that if quality measures for the more relevant year were obtainable, these would reveal an even stronger relationship with earnings. However, the question of effects of college quality are too important to put aside on the grounds that current data are imperfect.[16]

Table 2 provides the estimation of earnings functions like (5) with different quality measures. It appears that regardless of how quality is measured, the traits of one's school significantly affect log of subsequent earnings (i.e., log of 1969 earnings). These affects are after controlling for the individual's IQ, years of education and experience. The t-values on quality (ten measures) range from 3.744 to 6.049 with 1,506 degrees of freedom.

We should pause at this point to note that the coefficient on years of schooling is only slightly over .03 in all the earnings functions of Table 2. These coefficients should not be interpreted as the rate of return to years of education. As we noted in discussing equation (2),

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16 It has been suggested that if graduates from certain colleges earned high incomes for reasons unrelated to our quality measures, they might have subsequently donated large sums to their Alma Mater. This would have enabled colleges to then obtain high markes in our quality measures. In this case high incomes supported high quality. Moreover high current incomes might be due to current prestige of ones Alma Mater regardless of the quality during the time attended.

TABLE 2

Earnings Functions with Different Aspects of College Quality

	Gourman Overall	Gourman Academic	Average Salary	S.A.T. Verbal	S.A.T. Math.	Inst.Dept. Res. and Library Expenses	Basic Income	Basic Expendi-tures	Astin Intell.	Astin Select.
Constant	1.722 (9.970)	1.720 (9.939)	1.512 (8.366)	1.340 (6.781)	1.264 (6.256)	1.859 (11.00)	1.847 (10.87)	2.036 (11.78)	1.517 (8.359)	1.403 (7.233)
IQ	.03536 (4.911)	.03560 (4.946)	.03232 (4.467)	.03352 (4.634)	.03209 (4.418)	.03431 (4.745)	.03556 (4.913)	.03543 (4.859)	.03252 (4.487)	.03355 (4.629)
Years of education	.03142 (4.347)	.03174 (4.347)	.03052 (4.198)	.03420 (4.750)	.03473 (4.838)	.03176 (4.356)	.03370 (4.632)	.02448 (3.000)	.03147 (4.337)	.03327 (4.600)
Experience	.03523 (2.630)	.03573 (2.665)	.03927 (2.935)	.03441 (2.571)	.03454 (2.584)	.03667 (2.736)	.03430 (2.554)	.03657 (2.716)	.03649 (2.729)	.03479 (2.598)
Experience^2	-.0008265 (-2.506)	-.0008403 (-2.547)	-.0009354 (-2.839)	-.0008216 (-2.495)	-.0008233 (-2.502)	-.0008651 (-2.622)	-.0008042 (-2.433)	-.0008622 (-2.601)	-.0008708 (-2.645)	-.0008167 (-2.478)
Quality	.0005812 (5.124)	.0005576 (5.047)	.0004822 (6.049)	.001189 (5.520)	.001259 (5.778)	.0001324 (5.175)	.00008250 (4.373)	.00004069 (3.744)	.008721 (5.808)	.01011 (5.297)
R^2 5	.07632	.07584	.08251	.07885	.08060	.07663	.07199	.06887	.08080	.07740
R^2 4	.06020	.06020	.06020	.06020	.06020	.06020	.06020	.06020	.06020	.06020
Quality mean	519.664	538.447	10339.5	555.124	576.404	115.108	1877.32	2270.97	580.304	59.5592
Elasticity	.3020	.3002	.4985	.6600	.7256	.1524	.1548	.0924	.5060	.6021
R^2	.01612	.01564	.02231	.01865	.02040	.01643	.01179	.00867	.02060	.01720

Note: R_4^2 is the R^2 after the fourth step (only YRS., IQ, EXP and EXPSQD).

R_5^2 is the R^2 with all five variables includes ΔR^2 is $(R_5^2 - R_4^2)$ and is the additional explanatory power provided by the quality variable.

the rate of return to years of schooling equals the coefficient on years, r, times $\frac{1}{k}$ where

$$k = \frac{\text{Actual opportunity cost plus direct costs}}{\text{Annualized opportunity costs.}}$$

Hence the coefficient on years is the rate of return only if k equals 1. If direct costs equal student earnings, exactly 100 per cent of potential income would be invested in obtaining human capital, k would equal 1 and r would be the rate of return.

Our sample contains people who almost always went to college under the G.I. Bill of Rights. These students had no direct costs of schooling and received subsistence payments as well. As an approximation we assume that, as students, our sample members received \$100 per month plus tuition under the G.I. Bill.[17] From the 1950 Census we can deduce that a white high school graduate aged 25 to 29 earned \$3,008 per year on average.[18]

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17 President's Commission on Veterans Payments, The Historical Development of Veterans Benefits in the U.S., G.P.O., 1956, p. 156. The Servicemen's Readjustment Act, known as the G.I. Bill of Rights passed in the 78th Congress 1944, paid up to \$500 per year tuition plus \$50 per month with no dependents or \$75 per month with one or more dependents. In 1945 the monthly payments with one or more dependents was raised to \$90 and in 1948 was raised to \$105 with one dependent and \$120 with more than one dependent.

18 Census of Population, 1950, Special Report P.E. No. 5B, Education, G.P.O., 1953.

This was assumed to be the foregone earnings of people in the sample. Hence it appears that k equaled roughly .35106 and $\frac{1}{k} = 2.85$.[19,20]

In order to estimate rates of return to years in college, we should multiply the years coefficient by 2.85. The rates of return appear to be roughly 9.7 per cent. Gary Becker estimated the returns to a white male college graduate to be 13 per cent in 1949.[21]

There are several reasons why the present estimates are below those of others. First, our sample includes only people who have at least some college education; and so, our coefficients reflect the return to an extra year of college not the return to college training compared to the return to high school attendance. The second reason for the low rate of return to higher education is the preponderance of teachers in our sample. Teachers have high education and relatively low annual earnings. Finally an examination of the dropouts in our sample indicates that they were usually pulled out of school by good earnings opportunities, not pushed out due to poor achievement.

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19 Assuming a nine month school year,

$$k = \frac{3/4 \times 3008 - 1200}{3008} = .35106$$

20 Barry R. Chiswick should be explicitly acknowledged for the point made in the last several paragraphs.

21 G. S. Becker, Human Capital, National Bureau of Economic Research, 1964. Of course Becker acknowledges the crudeness of the estimate.

Another reason for the apparent low payoff to extra "raw years" in school is that we are controlling for college quality. It is probably the case that those with more years also attended higher quality institutions.[22] Thus part of the return to extra years is reflected in the returns to quality rather than returns to years. The coefficient on years rises to slightly over .04 when quality variables are omitted from the earnings function; and, this would imply a rate of return to years not controlling for quality of about 12 per cent. Of course, the ability variable also detracts from the coefficient on years, since there is a positive relationship between innate ability and educational attainment.[23]

After establishing that quality is important, however measured, the task of inferring which aspect of quality is most important is more difficult. Table 2 shows that average faculty salary has the highest t-value, closely followed by the average S.A.T. scores of entering freshmen and Astin's measures of intellectuality and selectivity. One is tempted to conclude that faculty quality and peer group effects are the most important (in terms subsequent earnings) features of college quality.

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[22] The correlation between years and quality of the last school attended is about .25.

[23] Taubman and Wales, estimate an upward bias in the coefficient on years when IQ is omitted of about 30 per cent.

The peer group effects are in line with the conclusions of James Coleman in his study of lower levels of education; and Eric Hanushek has found similar affects of teachers at the elementary school level.[24]

The R-squared in the earnings function before adding the quality variable was .0602. The addition of the average salary variable raises the R^2 by .0223 to .0825. Once again, the quality variables measuring student characteristics add the next largest amounts to R^2.[25] Interestingly, according to the t-test and the addition to R^2 criteria the income and expenditures per full time equivalent student are the least important quality variables. The Gourman statistics which purport to take all factors into account, fall somewhere between the power of the faculty and student quality measures, and the expenditure measures.

The relative weakness of the expenditure data might be explained by the fact that they are deflated by the number of full-time equivalent

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[24] J. Coleman, et al, Equality of Educational Opportunity, Washington, G.P.O., 1966, and E. Hanushek, Education and Race, 1972.

[25] It has been suggested that the average college SAT variable might be a better proxy for the innate ability of the particular student than is the ability variable we use. The average SAT variable may be picking up ability traits of the individual not captured by our individual ability measure. If this were the case, the suggestion of a peer group affect would be wrong. To really confirm the peer group affect would require both individual and college SAT scores but we lack the former. It would also be useful to have variance of SAT by college which is not available.

students. Indeed, average faculty salary, a prime component of expenditure is the most powerful measure of quality. Welch has argued that for state elementary and high school systems, size is a factor having a significant positive effect on earnings; that is an important aspect of school quality as we define quality.[26] If scale economies are a positive aspect of college quality, then the expenditure data deflated is actually a ratio of two factors each a positive influence on earnings. If expenditures per student are high because expenditures are high, holding constant size of college, we would expect a strong positive relationship with later earnings. On the other hand, if the variable is large because number of students is small, holding expenditures constant, we would expect a negative relationship between the ratio and income. In a large sample of schools, the expenditures per student probably vary for both reasons and so the overall effect is blurred. Moreover, only part of each dollar spent finds its way into projects which make students more productive (i.e. what value is there to earning ability of gardening expenses for the college greenery). Of course a happier student may learn more and hence earn more.

Table 3 reestimates the earnings functions for six of the cases of Table 2. The results are similar except it appears that undergraduate quality is more important for those with sixteen or less of schooling

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26 F. Welch, "Measurement of the Quality of Schooling," American Economic Review, May 1966, p. 379.

TABLE 3

Earnings Functions with Undergraduate and Graduate Quality Separated

	Gourman Overall (1)	Average Faculty Salary (2)	Average S.A.T. Math. (3)	Instruction, Research and Library Expenditures (4)	Astin Intellectual (5)	Astin Selectivity (6)
Constant	1.416 (6.670)	1.226 (5.486)	1.314 (5.788)	1.705 (8.576)	1.351 (6.112)	1.320 (5.786)
IQ	.0312 (4.462)	.0313 (4.474)	.0343 (4.887)	.0311 (4.413)	.0326 (4.629)	.0340 (4.835)
Years of education	.0474 (4.382)	.0627 (5.833)	.0651 (5.908)	.0427 (4.354)	.0582 (5.389)	.0605 (5.487)
Experience	.0300 (2.350)	.0291 (2.279)	.0260 (2.020)	.0312 (2.438)	.0279 (2.168)	.0267 (2.073)
$Experience^2$	-.00068 (-2.159)	-.00066 (-2.088)	-.00057 (-1.809)	-.00072 (-2.286)	-.00062 (-1.973)	-.00059 (-1.854)
$Z \times Q_{UG}$[a]	.00083 (7.176)	.000039 (7.161)	.00051 (5.595)	.00017 (6.184)	.0060 (5.901)	.0059 (5.410)
Q_{GRAD}	.00062 (5.245)	.000026 (5.487)	.00031 (3.884)	.00012 (4.340)	.0040 (4.087)	.0038 (3.768)
Pilot dummy	.4149 (3.414)	.4090 (3.366)	.4156 (3.398)	.4178 (3.427)	.4208 (3.444)	.4031 (3.294)
Teacher dummy	-.3128 (-5.489)	-.3287 (-5.748)	-.2889 (-5.015)	-.3280 (-5.764)	-.3090 (-5.381)	-.3130 (-5.440)
M.D. dummy	.7461 (4.988)	.7424 (4.965)	.6672 (4.437)	.7095 (4.737)	.7091 (4.724)	.6948 (4.621)
Lawyer dummy	.2541 (3.640)	.2473 (3.546)	.2229 (3.184)	.2427 (3.471)	.2328 (3.326)	.2287 (3.263)
R^2	.1392	.1394	.1281	.1337	.1299	.1268

[a] Z = 1 if education is 13 to 16 years, 0 otherwise. Hence this variable shows effect of Q_{UG} on those without graduate work.

than in graduate quality for those who go on.[27] The coefficients on Q_{UG} were higher and the t-tests more significant in all cases when compared to Q_{UG}. The second change in the specifications of Table 3 is that four dummy variables were inserted to account for "peculiar" occupations. These served to increase the coefficients on years for reasons discussed above (pilots had low education and high earnings whereas teachers generally had the reverse).

We can calculate an income elasticity of quality, the percentage change in income for a percentage change in quality. However, these elasticities cannot be used to compare impacts of quality. A 1 per cent change in average S.A.T. level is not comparable to a 1 per cent change in average salary. These elasticities are presented in Table 2. If we could calculate the cost of a 1 per cent change in each of the quality measures, only then could we see the returns to each. The relationships between size, expenditures and quality will be discussed below.

We see that each of the quality measures is an important variable in the earnings function. The question arises whether all the measures

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[27] A positive correlation between Q_{UG} and Q_{GRAD} for those with more than sixteen years implies the coefficient on graduate quality is higher than it would be if Q_{UG} were entered for those with more than sixteen years. When this was done the Q_{UG} variable was not significant for those with more than sixteen years. On the other hand several individuals attended graduate schools for which average faculty salary and average S.A.T.'s were not available. Hence in those cases the Q_{GRAD} appears as zero and this tends to lower the slope of the graduate quality coefficients in those two cases.

are really standing for the same thing or whether they are measuring truly different features of college quality. Table 4 presents the correlations between pairs of quality measures, including school size (enrollment), where observations are schools not individuals. In general, these correlations exceed .5.

Table 5 presents two specifications of the earnings equation which include more than one quality variable. In the first, it is evident that average salary and S.A.T. scores have separate and statistically significant influence on income. The second version shows that when additional types of quality measures are added, the importance of faculty and student effects still stands out, but the other variables add nothing extra statistically. It appears that two separate and important aspects of quality can be identified; namely, faculty quality, and peer group (student) effects.[28] The other variables to measure quality apparently relate to income only as proxies for these two effects.[29]

IV. <u>Towards Estimates of Rates of Return to Quality</u>

To better understand the meaning of quality of higher education, it is useful to digress for a moment from the earnings model and study more explicitly the relationship among quality measures. We have three types

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28 As stated earlier, the significance of the average S.A.T. scores might be measuring the affects of students' own abilities not captured by IQ. However, these seem to be no reason by 1963 S.A.T. would better represent ability than would the ability measures taken in the Air Force usually before college attendance.

29 Of course it might be that other aspects of quality are important but are omitted from our model or merely poorly measured.

TABLE 4

Correlations Between the Various Measures of College Quality

1. Average Faculty salary	.6295	.6540	.7460	.6870	.7364	.8016	.7746	.6141	.6530	.2535
2. S.A.T. verb.		.9069	.5603	.5649	.6101	.5888	.5545	.6592	.7667	-.0978
3. S.A.T. math.			.6068	.6093	.6613	.6169	.5927	.7205	.7758	-.0888
4. Dept. Res. Inst. and Libr. Exp.				.8178	.9555	.7540	.7262	.6247	.6312	.0482
5. Basic income					.8413	.6738	.6390	.5977	.6193	.0211
6. Basic expenditures						.7127	.6764	.6576	.6759	-.0803
7. Gourman overall							.9827	.6674	.6976	.3084
8. Gourman academic								.6615	.6811	.3318
9. Astin intellectuality									.7399	.0114
10. Astin selectivity										.0182
11. 1960 enrollment										

TABLE 5

Earnings Functions with Several Quality Variables

Constant	1.332 (6.761)	1.300 (5.665)
IQ	.03105 (4.285)	.03099 (4.265)
Years of education	.03053 (4.206)	.03055 (4.190)
Experience	.03781 (2.827)	.03766 (2.310)
Experience^2	-.0009073 (-2.756)	-.0009029 (-2.736)
Average salary	.00003392 (3.343)	.00003342 (2.108)
S.A.T. verbal	.0006215 (2.272)	.0005807 (1.848)
Expenditures: Inst. Dept., Res., Library		-.00001069 (-0.2147)
Astin selectivity		.001087 (0.3269)
Gourman academic		.00001541 (.07664)
R^2	.08564	.08573

of quality units; expenditures in dollars, enrollment (if size is a factor), and points on a scale. One of the quality features measured in dollars (average salary) and one measured in points (S.A.T. scores) stand out in the earnings model. Table 6 presents an attempt to relate the S.A.T., Gourman, and Astin indexes of quality to total expenditures, average salaries, and school size. The auxiliary equations can be related to the income elasticities of quality from the earnings functions to estimate rates of return to quality. It is obvious that the non-dollar quality measures are significantly influenced by expenditures as a whole, faculty salaries and size of student body. Size is negatively related to average S.A.T. scores and the Astin measures; that is, better peer group influences apparently are found in smaller schools. Gourman ratings are positively influenced by size. Interestingly, we explain about 50 per cent of the variance in the peer group measures by our model but 70 per cent of the Gourman ratings are explained.

The last four rows in Table 6 show the coefficients on basic expenditures (library, research and instruction) when used alone to explain the non-dollar quality measures. We can use the coefficients on basic expenditures when used alone to calculate a quality elasticity of expenditures per student; that is, the percentage change in quality measure per percentage change in basic expenditures per student. This assumes a change in expenditures is associated with changes in many kinds of quality. These figures appear as row 3 of Table 7. Row 1 of Table 7 rewrites the income elasticities of the various quality measures. It can

TABLE 6

Regression Relationships Among Quality Variables

	S.A.T.		Gourman		Astin	
	Verbal	Math.	Overall	Academic	Intell.	Select.
Constant	339.9	355.1	94.9	97.5	28.1	31.0
Basic expenditures	.0149 (2.4495)	.0232 (3.7548)	.0[illegible]91 (6.8916)	.0495 (6.1135)	.0055 (5.4403)	.0045 (5.2771)
Undergraduate enrollment	-.0039 (-4.0248)	-.0036 (-3.6735)	.0063 (5.5849)	.0075 (5.8327)	-.0001 (-.5674)	-.0001 (-.8106)
Average faculty salary	.0031 (6.7456)	.0200 (6.4415)	.0269 (7.5304)	.0274 (6.7516)	.0019 (3.7439)	.0020 (4.7070)
Adj R^2	.4740	.5206	.7114	.6700	.4629	.5043
Mean Qual.	540.8	563.7	442.5	454.4	54.01	56.02
S.D.	60.99	64.87	96.4	102.4	10.1	8.8
Coefficient on basic expenditures when used alone	.0474	.0547	.0876	.0882	.0085	.0075
Adj R^2	.3694	.4348	.5058	.4551	.4299	.4544
Coefficient on expenditures for Library, Res. and Inst. when used alone	.0724	.0834	.1541	.1576	.0134	.0117
Adj R^2	.3109	.3654	.5665	.5253	.3875	.3958

(226 schools with all data are the units of observation).

be shown that the product of the income elasticity of quality (e_Q) and the quality elasticity of expenditures (e_E) is the percentage change in income resulting from the change in the particular quality variable which is the result of a 1 per cent change in basic expenditures per full-time equivalent student.[30] These numbers appear as row 4 of Table 7. Row 5 of Table 7 is simply the reciprocal of row 4; or, the per cent by which basic expenditures per student must be raised in order to augment a particular quality variable by enough to increase an individual's 1969 income by 1 per cent. These numbers are comparable to the simple income elasticity of quality (or its reciprocal) for basic expenditures per student.

From Table 7 we see that a 10.82 per cent increase in basic expenditures per student would result in a 1 per cent increase in income per student. Included in any amount of increase in expenditures are expenditures for college attributes not related to subsequent earnings of students. On the other hand to get comparable figures for other quality variables we must ask both by how much quality can be increased by

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1 per cent increase in expenditures $\rightarrow$ e_E per cent increase in Q

$\frac{1}{e_E}$ per cent increase in expenditures $\rightarrow$ 1 per cent increase in Q

1 per cent increase in quality $\rightarrow$ e_Q per cent increase in Y

$\frac{1}{e_E}$ per cent increase in expenditures $\rightarrow$ e_Q per cent increase in Y

1 per cent increase in expenditures $\rightarrow$ $e_Q e_E$ per cent increase in Y

TABLE 7

An Attempt to Make the Various Quality Measures Comparable

	S.A.T.		Gourman		Astin		Average Salary	Basic Exp.
	Verbal	Math.	Overall	Academic	Intell.	Select.		
1. Income elasticity of quality	.6600	.7256	.3020	.3002	.5060	.6021	.4985	.0924
2. $\frac{dQ}{dE}$	.0474	.0547	.0876	.0882	.0085	.0075	1.4966[a]	
3. $\frac{\% \Delta Q}{\% \Delta E}$	.132874	.147108	.300115	.294258	.238585	.202963	.242673	
4. $\frac{\% \Delta \text{Inc.}}{\% \Delta \text{Exp.}}$	.087696	.106741	.090634	.083336	.120724	.122204	.120972	.0924
5. $\frac{1}{\frac{\% \Delta \text{Inc.}}{\% \Delta \text{Exp.}}}$	11.40	9.37	11.03	11.32	8.28	8.18	8.27	10.82

[a] This is derived from a regression similar to the others with average salary as the dependent variable. This regression is not shown in Table 5.

increasing expenditures per student, and also, how quality improvements so measured affect subsequent earnings. In general, all of the quality variables have greater impacts on income in percentage terms (row 1) than does the expenditures measure; that is a 1 per cent change in the non-dollar quality measures effects a greater change in subsequent earnings than does a 1 per cent change in expenditures. However, large costs must be incurred to change these other aspects of quality (row 3).

By making expenditures, colleges may attempt to increase their quality; in our terms, to acquire characteristics which enable students to earn more later. As a college reaps the benefits of higher expenditures, faculty quality should rise, students entering should get better, perhaps the level of intellectuality should rise and Jack Gourman ultimately would revise upward his index for that college's quality. Row 3 of Table 7 shows how various measures of quality change as expenditures rise, on average. It appears difficult to raise the level of average S.A.T. scores by expenditures (e_E of the S.A.T's are about .14). It is easier, of course, to improve average salaries by increasing expenditures per student (e_E of .24). This e_E for average salary is sensitive to faculty/student ratios but the measure is taken at the mean of our sample of colleges. It appears that it would take roughly the same percentage increase in expenditures per student (8.27 per cent) directed at improving average faculty salaries as it would take expenditures for improvement of the intellectual atmosphere to raise a former student's 1969 income by 1 per cent. A smaller increase (8.18 per cent) in expenditures would be required to raise the selectivity by 1 per cent. For the selectivity measure although e_E is the same as for the other two quality measures, e_Q is somewhat larger. The difficulty in raising average S.A.T. scores by spending (low e_E) imply that expenditures would have to be raised by a larger percentage (11.4 or 9.4 per cent) in order to increase these peer characteristics enough to increase income by 1 per cent.

The regression results have indicated that there are two distinct features of quality operating significantly; namely, faculty effects and peer group effects. It is also apparent from the significance of average salary in the regressions explaining the student quality variables that these attributes are strongly related. However, due both to the differences in cost of altering various types of quality and the varying impacts of the quality measures on income, the "rates of return" to costs incurred improving various dimensions of quality differ. The figures in row 4 are rates of return to a 1 per cent increase in expenditures per student directed into improving a particular quality attribute.

It appears that a 1 per cent increase in expenditures per student might result in from .087 to .122 per cent increase in subsequent annual earnings depending upon the direction these expenditures take (i.e, what aspect of quality is improved by the expenditures).

If mean total expenditures per student of colleges is $1,516 and mean 1969 income is $15,000, then the implication is that a 1 per cent increase in expenditures (.01 x $1,516) yields a return of .00088 times $15,000. Hence the rate of return would be $\frac{.88 \times 15}{15.16} = .87$, or 87 per cent return in the year 1969. We see that expenditures directed at increasing college quality might yield returns of anywhere from 87 to 120 per cent. Of course these returns come twenty years after the expenditures and so the present value of this return at the time the decision whether or not to increase quality was small. At a 6 per cent discount rate, a 100 per cent return twenty years hence is equivalent to a 33 per cent return in the current period (the present value of 100 twenty years hence at 6 per cent is 33).

However if on average income expected twenty years after college had been only $10,000, then the present value of return on a 1 per cent increase in expenditures would be only 20 per cent. A 20 per cent return to expenditures on educational quality indicates the importance of and payoff to educational quality. It should be noted that these results apply for the age at which the age-education profiles are furthest apart and may be different at other ages. Decisions about investment in college quality should be based on returns in each post-school year of those who attended. If as is shown below, returns to quality rise over time in the labor force, then the present value of all returns to improved quality implied here seems reasonable. The changing value of college quality over the life cycle can and will be studied during the current project. Regressions like those in Table 2 will be estimated using initial year and 1955 income to complement the current work with 1969 income data.

We now return to the question of the relationship between quality and earnings. We shall look at theinteractions between quality, ability, and years of schooling, and further interactions among the quality variables themselves.

V. Interactive Models

So far, our analysis has studied the sample as a whole, and tested for a linear relationship between college quality (quality of the last college attended) and subsequent income of those who attended, controlling for appropriate other factors which would confound the income-quality relationship. That various traits of colleges are important determinants of later financial success has been clearly established. It is time now to probe more deeply into the income-quality relationship, in order to see how college quality affects different types of individuals in our sample and how quality interacts with other variables in our earnings equation.

First, separate regressions similar to those presented in Table 2 (i.e. including IQ, YRSED, EXP, and EXPSQD along with last quality) were estimated for individuals in our sample with IQ's above the sample mean (700 observations) and below the mean (811 observations). The question asked is whether the effect of quality differed according to the ability of those who attended. Table 8 presents the elasticities derived as the product of the coefficient on quality ($d \ln Y/dQ$) and the mean values of quality. According to the t-test, the impact of quality is significantly greater for the higher ability subsample for all definitions of quality but one.[31] (For S.A.T. math the elasticities were not significantly

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[31] The t-test was H_o: $\beta_H = \beta_L$, where β_H is the coefficient of quality for the high ability half of the sample and β_L is the quality coefficient for the low ability half.

TABLE 8

Income Elasticities of Quality[a]

	Gourman		Average Salary	S.A.T.		Expenditures: Instr., Dept. Res., and Lib.	Basic Income	Basic Expendi-tures	Astin Intell.	Astin Select.
	Overall	Academic		Verbal	Math.					
All observations	.3020	.3002	.4985	.6600	.7256	.1524	.1548	.0924	.5060	.6021
High IQ	.3563	.3654	.5761	.7703	.6937	.1744	.2143	.1217	.5762	.6862
Low IQ	.2492	.2375	.4328	.5636	.7579	.1283	.0850	.0480	.4470	.5207
t[b]	5.003	5.9337	3.3917	2.9093	.8230	5.6336	13.1944	8.8326	2.8618	2.5765

[a] Controlling for YRSED, EXPER, EXPERSQD, and IQ.

[b] The tests are whether there are significant differences in the elasticities for the high and low IQ parts of the sample. Differences are significant where t-values exceed 2.0 (approximately)

The sample was divided into those with IQ above the mean and those below the mean of the whole sample of 1511.

different.) These regressions from which Table 8 is derived reveal that coefficients on IQ were generally smaller for the high ability group, the coefficients on years in school and experience generally larger for the high ability group. The model explains 9 to 10 per cent of the variance in 1969 income for those with ability above the mean, but only 4 to 5 per cent of the variance of income of the lower ability group was explained.[32]

These results lead us to separate the sample further, into ability quartiles. Table 9 presents the coefficients on quality, undergraduate quality for those with sixteen or fewer years and graduate quality for those who achieved more than sixteen years. We must remember that there were ten variables in the earnings function although we only present the quality coefficients and the elasticities. For the lowest three ability quartiles both the quality coefficients and the income elasticities of quality are larger for those who attend sixteen or fewer years than for those with graduate work. For the top ability quartile quality means more for those who have graduate work. Also, the effect of quality appears greatest--no matter the number of years--for those in the highest ability quartile. Next greatest impact of quality is on those in the lowest ability quartile. The students in the middle two ability quarters saw their incomes least influenced by quality of college. We have to

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32 When S.A.T. and average salaries are put in together, their affects are both more significant (t-test) and larger (size of coefficient) for the high IQ half of the sample.

TABLE 9

Income Elasticities of College Quality by IQ Quartiles

	Low IQ	2	3	High IQ
Coefficient on Z x Q_{UG}	.00094	.00061	.00050	.00097
(t-value)	(3.674)	(2.794)	(1.922)	(5.041)
Mean Q_{UG}	476.5	490.6	503.5	528.0
Elasticity	.448	.299	.252	.512
Coefficient on Q_{GRAD}	.00045	.00026	.00028	.0011
(t-value)	(1.691)	(1.138)	(1.044)	(5.393)
Mean Q_{GRAD}	501.6	518.6	532.1	552.0
Elasticity	.226	.135	.149	.607
Observations	376	421	338	434

Notes: 1. The quality measure used is the Gourman Overall Index since this was available for all schools.

2. The coefficients are from an earnings function explaining ln of 1969 income by years of education, experience, experience squared, IQ, and dummies for teachers, M.D.'s, lawyers and pilots.

3. Income elasticities of quality are the coefficients times the mean quality.

4. $Z = 1$ if education ≤ 16 years and 0 otherwise.

conclude that the interaction between college quality and individual ability is nonlinear.

Tables 8 and 9 indicate that college quality does influence incomes of the more able students more than it influences other students. Columns 3 and 4 of Table 10 reveal only a weak linear interaction between quality (now measured as average S.A.T. verbal and average faculty salary rather than the Gourman Index). This is to be expected due to the previous[33] indication of nonlinearity.

Table 10 also tests for several other types of linear interactions. These regressions are comparable to those in Table 2 (where the R^2 when S.A.T. verbal was the quality measure was .07885 and when average salary stood for quality was .0825). The negative coefficient on quality squared (S.A.T. verbal) suggests a slight lessening of the impact of quality as the level of quality rises. The t-value here is -1.343.

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33 Here the interaction term is specified as the product of the two variables concerned. That is, if

$$\ln Y = a + b\ QUAL + c(QUAL) \times (IQ)$$

then

$$\frac{d \ln Y}{dQ} = b + c\ IQ$$

which differs statistically from b if c is significantly different from zero. This is a specific type of interaction. The high correlation between QUAL and (QUAL) x (IQ) tends to cloud the interpretation of the results. A quality squared term tests whether the affect of quality depends on its level.

TABLE 10
Earnings Functions with One Interaction Term

	S.A.T. Verbal (1)	Average Salary (2)	S.A.T. Verbal (3)	Average Salary (4)	S.A.T. Verbal (5)	Average Salary (6)
Constant	.3754 (.4927)	1.587 (4.066)	1.390 (6.994)	1.527 (8.415)	1.850 (1.896)	1.023 (1.481)
I.Q.	.03417 (4.700)	.03256 (4.473)	-.05133 (-.8881)	-.004114 (-.1029)	.03395 (4.668)	.03234 (4.441)
Years of education	.03635 (5.078)	.03324 (4.605)	.03667 (5.125)	.03356 (4.649)	.006485 (.1090)	.06290 (1.550)
Experience	.03067 (2.306)	.03512 (2.640)	.03153 (2.368)	.03570 (2.682)	.03035 (2.279)	.03591 (2.692)
Experience^2	-.0007403 (-2.263)	-.0008400 (-2.567)	-.0007506 (-2.294)	-.0008512 (-2.600)	-.0007259 (-2.217)	-.0008590 (-2.617)
Quality	.004657 (1.770)	.00003413 (.5338)	-.001058 (4.788)	.00004472 (5.382)	.0002603 (.1504)	.00009465 (1.461)
Quality^2	-.000003083 (-1.343)	.5805 D-9 (.2027)				
Quality x I.Q.			.0001517 (1.488)	.000003481 (.9324)		
Quality x yrs.					.00005415 (.5094)	-.000002889 (-.7416)
R^2	.08110	.08425	.08136	.08476	.08015	.08456

D-X means move decimal point X places to the left. Use this for all QXID.

Finally, the effect of the quality of the last school attended did not seem to be a linear function of the number of years attended (columns 5 and 6). This is not surprising in light of the relative importance of quality to those who do and do not have graduate training demonstrated in Table 9. The earnings functions' explanatory power is only slightly improved by the addition of the interaction term.[34]

The earnings functions were then rerun to include three interactions simultaneously; quality and IQ, quality and years of education, and IQ and years. When this formulation was estimated for the whole sample, only weak interactions between quality and IQ (generally positive) and quality and years of education (generally negative) were found. The interaction between IQ and years was never significant. Of course, by now multicollinearity is becoming a problem.

However when only those with IQ's above the sample mean were included, a significant interaction (negative) between IQ and years was revealed. The interactions with quality now appeared weaker than for the whole sample. The estimates using people below mean IQ do not show

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34 Since both S.A.T. verbal and average salary were significant when used together, their combined interactions were studied in a single regression. The coefficient on the product of the two quality variables was not different from zero, indicating that the relationship between either quality measure and income is independent of the level of the other quality measure. The coefficients on the squared quality terms and on each quality measure times years were not significant. However, the coefficient on the SAT x IQ variable was significant according to the t-test (positive) and the average salary x IQ coefficient was almost significant (negative).

a significant IQ x years interaction, but the interaction between quality and years (negative) becomes stronger.

The results just discussed are not presented in a table here for brevity. The implication from this discussion is that for people with below average IQ, quality of college attended is more important for earnings the fewer years of college attended. Also, for people with above average ability the relationship between IQ and income is stronger the fewer years of education obtained. One problem with these formulations is that the arguments in the interactive earnings function become highly correlated. The strong differences revealed when the simple earnings function was run for subsamples, compared to the results from the interactive model, lead us to stress the procedure of dividing up the sample and running regressions for subsets of observations.

Table 11 contains simple earnings functions for the sample divided not only into high and low IQ groups, but within these, into those who attended high or low quality colleges.[35] These regressions indicate that the impact of quality, as measured by average S.A.T. scores (math)

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[35] That is, there are four regressions:

(1) Those with ability greater than sample mean attending schools with average math S.A.T. of entering freshmen above the sample mean.

(2) Those with high ability going to below average quality colleges.

(3) Those with low ability going to above average quality colleges.

(4) Those with low ability in below average quality colleges.

TABLE 11

Simple Earnings Functions for Subsamples Divided by Own Ability and School Quality

	Individual High IQ	Individual High IQ	Individual Low IQ	Individual Low IQ
	High SATM Average Student	Low SATM Average Student	High SATM Average Student	Low SATM Average Student
Constant	.6447 (1.402)	.4154 (.8258)	2.726 (5.402)	1.105 (2.785)
IQ	.0345 (1.835)	.0105 (.4948)	.0487 (1.913)	.0436 (2.267)
Years of education	.0543 (4.124)	.0621 (4.733)	.0233 (1.740)	.0282 (2.721)
Experience	.0534 (2.207)	.0300 (1.250)	-.0089 (-.3646)	.0289 (1.427)
Experience^2	-.0010 (-1.704)	-.00049 (-.8318)	.0002 (.2782)	-.0007 (-1.385)
Quality[a]	.0012 (2.208)	.0020 (2.467)	-.00008 (-.1231)	.0019 (3.112)
R^2	.0764	.0792	.0185	.0486
Observations	494	465	448	656
Mean IQ	1.96	1.74	-1.01	-1.15
Mean SATM	633	539	620	529
$\frac{\%\ \Delta\ \text{Income}}{\%\ \Delta\ \text{Quality}}$	.7596	1.178	-.0496	1.0051

[a] Quality measured by average SATM scores of entering freshmen.

of entering freshmen, is greatest at poorer schools. The coefficient on quality is .002 in both quarters of the sample where quality is below average and .0012 for the high quality-high ability group. The income elasticities of quality follow the same pattern. Interestingly, for the low individual IQ high average S.A.T. group, the coefficient on quality is not significantly different from zero. The t-values on average S.A.T. are highest for the low school quality group as well.

These regressions indicate a higher return to years of education for the high ability people, regardless of college quality. The only group where IQ seems to be less important than others in terms of later earnings is where high ability people attend poor schools. Returns to experience are also higher for the high ability group.

Table 12 tests for interactions within each of these four parts of our sample. There were only a few significant interactions. There was a significant negative coefficient on the quality times years variable for the high ability, low quality group, and a strong positive interaction between quality and ability in the low ability, high quality group. Comparing the R^2's in Tables 11 and 12, it can be seen that the interaction terms do add somewhat to the power of the model, but not a great deal. The conclusions from the last two tables are that the earnings functions for people falling into each of the four categories do look different. However precise patterns by school quality and individual ability are not immediately visible.

TABLE 12

Earnings Functions for Four Subsamples
Each Containing Three Interactions

	High IQ, High SAT	High IQ, Low SAT	Low IQ, High SAT	Low IQ, Low SAT
Constant	3.657 (1.134)	-6.186 (-1.623)	-2.295 (-.6702)	-2.293 (-.7495)
IQ	.3559 (1.301)	-.1047 (-.2173)	-.7548 (-1.619)	-.07983 (-.2540)
Years of education	-.1587 (-.8189)	.5565 (2.298)	.2762 (1.350)	.2520 (1.339)
Experience	.05258 (2.166)	.01442 (.5759)	-.007072 (-.2917)	.03228 (1.550)
$Experience^2$	-.0009944 (-1.662)	-.00009117 (-.1469)	.0001335 (.2239)	-.0008236 (-1.593)
Quality[a]	-.003825 (-.7374)	.01354 (1.907)	.008174 (1.492)	.008229 (1.425)
Quality x IQ	-.0003549 (-1.006)	.0008073 (.9045)	.001490 (2.159)	.0002513 (.4773)
Quality x years	.0003526 (1.131)	-.0008612 (-1.928)	-.0004208 (-1.280)	-.0004216 (-1.189)
IQ x years	-.005523 (-.5441)	-.01888 (-1.741)	-.007865 (-.6202)	-.0001279 (-.01299)
R^2	.08045	.08118	.03155	.04992

[a] Quality measured by average SATM of entering freshmen.

Table 13 looks at earnings functions separately for individuals with different educational attainments. Column 4 is the verification of the fact that undergraduate quality is not very important to those with graduate training, since the t-value on the coefficient on undergraduate quality of those with more than sixteen years is only 1.342. In this specification with all those who attended college pooled together, coefficients on the other variables in the earnings functions are averages of those with and without graduate work. However, when we separate the two groups, the results look different. Although graduate school quality is stronger, undergraduate quality is also highly significant for those with more than sixteen years. Effects of quality at all levels is clearly greater for those with more schooling if we add the effects of graduate and undergraduate schools for those who go on. Unfortunately, our sample of individuals for whom we have average S.A.T. or average salary for both graduate and undergraduate schools attended is small, and so, we would not be able to analyze ability subgroups, or quality subgroups broken down by attainment as well. Hence Table 13 refers only to the Gourman measure. Future work will be directed towards even greater subdivision of the sample. The focus of this paper has been to study the impact of the quality of the last college attended.

Table 14 serves to answer the allegation that quality measures are merely standing for other factors which affect earnings but not appearing in the functions above. For example if good college quality is merely a proxy indicating those who went into the professions then the

TABLE 13

Earnings Functions by Educational Attainment

	Those with 13-16 Years of Education (1)	Those with More Than 16 Years of Education (2)	Those with Data on Graduate Quality (16+ Years) (3)	Those with 13 or More Years of Education (4)
Constant	1.474 (10.04)	1.167 (3.929)	1.023 (3.469)	1.490 (11.92)
Years of education	.05506 (6.573)	.06859 (5.461)	.06500 (5.245)	.04932 (7.495)
Experience	.02110 (2.353)	.003859 (.2245)	.002474 (.1453)	.02096 (2.745)
$Experience^2$	-.00044 (2.033)	.0001824 (.3939)	.0002167 (.4727)	-.0004202 (2.220)
IQ	.02557 (4.702)	.013628 (5.111)	.03320 (4.715)	.02931 (6.725)
Undergraduate quality[a]	.0005380 (6.277)	.0006635 (5.356)	.0004469 (3.452)	.0001657 (1.342)
Graduate quality	- -	- -	.0006245 (5.272)	.0003543 (3.148)
UG x Z 1 if no graduate school 0 if graduate school	- -	- -	- -	.0004944 (4.039)

(continued)

TABLE 13 (concluded)

	Those with 13-16 Years of Education (1)	Those with More Than 16 Years of Education (2)	Those with Data on Graduate Quality (16+ Years) (3)	Those with 13 or More Years of Education (4)
Pilot	.5277 (6.047)	.2650 (1.287)	.2714 (1.334)	.5020 (6.373)
Teacher	-.3512 (3.527)	-.2660 (8.423)	-.2658 (8.503)	-.2939 (8.991)
M.D.		.7547 (9.503)	.7774 (9.890)	.7411 (8.772)
Lawyer		.2207 (4.867)	.2489 (5.515)	.2594 (5.687)
R^2	.07912	.29321	.31143	.14398
No. of observations	2,702	1,079	1,076	3,781
Mean Q_{UG}	471.642	478.590	478.909	473.625
Mean Q_{GRAD}		518.298	520.402	

[a] Quality refers to the Gourman index.

TABLE 14

Earnings Functions with Additional Control Variables

	All Observations	High IQ	Low IQ
Constant	.7573 (3.373)	.05543 (.1685)	1.270 (4.027)
IQ	.02420 (3.534)	.03074 (2.060)	.03679 (2.178)
Years of education	.06237 (8.547)	.07445 (6.845)	.05049 (5.107)
Experience	.02901	.04764 (2.448)	.01961 (1.191)
Experience^2	-.0006638 (-2.154)	-.0009024 (-1.901)	-.0005621 (-1.379)
Last Quality: average salary	.00003038 (2.008)	.00004049 (1.967)	.00002193 (0.9744)
SAT verbal	.0004127 (1.394)	.0006616 (1.568)	.0002727 (0.6497)
Expenditures: Instr., Departmental Res., Library	-.000002718 (-.05809	-.000005676 (-.09997)	-.00001098 (-0.1292)
Astin selectivity	.002651 (.8416)	.00007121 (.01517)	.003374 (0.7881)
Gourman: Academic	-.00003651 (-.1944)	-.00003216 (-0.1203)	.00001547 (.05180)
Pilot: 1=yes 0=No	.4699 (3.966)	.4604 (2.627)	0.4887 (3.022)
Health: 1=poor 0=otherwise	-.1171 (-.6593)	-.3141 (-1.363)	0.1706 (0.6162)

(continued)

TABLE 14 (concluded)

	All Observations	High IQ	Low IQ
Catholic: 1 = yes 0 = otherwise	.07717 (2.516)	.07727 (1.463)	.07799 (1.861)
Jewish: 1 = yes	.3631 (7.459)	.3304 (5.045)	0.3847 (5.205)
Married: 1 = yes	.1479 (2.844)	.3199 (3.819)	.05431 (0.8089)
Teacher: 1 = yes	-.3223 (-6.049)	-0.3832 (-4.792)	-0.2947 (-4.101)
Conservative: Liberal	-.02302 (-1.719)	-.04522 (-2.383)	-.007281 (-0.3836)
Business proprietor or self employed dummy (1 = yes)	.2989 (9.055)	.3380 (6.670)	0.2665 (6.065)
High socio-economic status	.0217 (.8077)	.02282 (.5868)	.02823 (0.7552)
Low socio-economic status	-.06322 (-1.710)	-.06880 (-1.251)	-.05728 (-1.138)
South 1 = yes	-.02378 (-.7973)	.05326 (1.197)	-.07845 (-1.931)
R^2	.21350	.27327	.16171

power of the quality variable may simply reflect occupational choice. Without discussing the elaborate earnings functions presented, we can simply note that the same two quality measures, S.A.T. and average salary, still stand out as the most powerful, and their coefficients are larger for the high ability half of the sample. Controlling for socio-economic background and occupation does not change our conclusions regarding the definition and impact of college quality.

VI. Results at Different Points in the Life Cycle

It is apparent that college quality, no matter how defined, does effect earnings twenty years after attending. It is also interesting to ask whether or not quality of college has an increasing or decreasing effect on earnings over time. To this end, earnings functions similar to those in Table 2 were estimated to explain log of 1955 income, rather than 1969 income; these are reported in Table 15. Quality does have a significant influence on 1955 earnings; however, no matter how quality is measured, its effect is smaller in 1955 than 1969, when the income elasticities of quality are considered. It should be noted, however, that in terms of significance of the quality variables (t-tests or addition to R^2) the 1969 and 1955 results are rather similar.

Comparing Tables 2 and 15, we see that IQ and experience have roughly the same effects on earnings in both years. However, the significance of the "experience squared" term is lower in 1955, probably since the earnings profile has not begun to turn down yet. Another difference is that the

TABLE 15

1955 Earnings Function
(1,428 Observations)

	Gourman		S.A.T.		Astin					
	Overall	Academic	Verbal	Math	Intell.	Select.	Average Salary	Library Expen.	Basic Income	Basic Expen.
Constant	1.677 (16.22)	1.682 (16.24)	1.378 (10.51)	1.324 (9.790)	1.540 (13.69)	1.438 (11.46)	1.567 (14.23)	1.808 (18.10)	1.783 (17.66)	1.949 (18.44)
IQ	.03513 (6.093)	.03543 (6.143)	.03380 (5.812)	.03284 (5.627)	.03302 (5.664)	.03396 (5.836)	.03345 (5.756)	.03441 (5.928)	.03586 (6.162)	.03569 (6.102)
Years of education	-.005004 (-.8263)	-.004803 (-.7923)	-.002163 (-.3614)	-.001502 (-.2518)	-.004209 (-.6980)	-.003279 (-.5446)	-.005025 (-.8303)	-.004454 (-.7350)	-.002188 (-.3617)	-.01004 (-1.475)
Experience	.009943 (2.479)	.01002 (2.495)	.009622 (2.395)	.009463 (2.357)	.009943 (2.479)	.009907 (2/466)	.01077 (2.686)	.01033 (2.572)	.009894 (2.452)	.01035 (2.565)
$Experience^2$	-.0005088 (-1.899)	-.0005189 (-1.935)	-.0005107 (-1.905)	-.0004949 (-1.848)	-.0005350 (-1.997)	-.0005036 (-1.877)	-.0005860 (-2.185)	-.0005409 (-2.016)	-.0004952 (-1.839)	-.0005455 (-2.021)
Quality	.0005053 (5.546)	.0004731 (5.334)	.0009328 (5.319)	.0009744 (5.545)	.006694 (5.551)	.007954 (5.161)	.00003608 (5.621)	.0001063 (5.171)	.00005909 (3.872)	.00003101 (3.539)
$R^2 5$	.05995	.05846	.05835	.05995	.05999	.05728	.06049	.05734	.04964	.04801
$R^2 4$	.03962	.03962	.03962	.03962	.03962	.03962	.03962	.03962	.03962	.03962
Quality mean	517.761	536.296	555.206	576.861	58.0056	59.5336	10321.7	1144.76	1865.83	2254.89
Elasticity	.26162	.25372	.51789	.56209	.38828	.47453	.37240	.12168	.11025	.06992
ΔR^2	.02033	.01884	.01873	.02033	.02037	.01766	.02087	.01772	.01002	.00839

coefficient on years of education variable is not significantly different from zero in 1955.[36] It should be noted that in 1955 respondents averaged about 6.6 years of experience. There is evidence that there is a positive relationship between years of education and investment in on-the-job training. It is likely that those with more years of schooling had been foregoing more earnings while investing on the job in the first few years of employment. However, by six years out returns to all human capital acquired appear, and so differences in income by education are clouded. On the one hand more earnings are foregone by the more highly educated, as they obtain more training. On the other hand, this group begins to reap returns to their human capital. The less educated group invests less in OJT (less income is foregone) but their earnings are lower. At this point in the life cycle income differences systematic with schooling might not show up.

Table 16 shows earnings functions explaining income in the initial year of employment (when experience for each respondent was zero). Years of education now have a significantly positive effect indicating returns of over 4.5 per cent to an additional year in school.

If the argument concerning the 1955 regressions were true, we would expect a negative relationship between income and years of schooling in the first year in the labor force. The argument is that the more

36 It has been suggested that the measure of education is poor for 1955 since it is education in 1969. However, the initial year regressions discussed below reveal education to have the more usual effects.

TABLE 16

Initial Year Earnings Functions
(1,508 Observations)

	Gourman		S.A.T.		Astin					
	Overall	Academic	Verbal	Math.	Intell.	Select.	Average Salary	Library Expen.	Basic Income	Basic Expen.
Constant	.4998 (3.560)	.5146 (3.660)	.4137 (2.189)	.4344 (2.214)	.4959 (3.139)	.3271 (1.818)	.4934 (3.204)	.4602 (3.464)	.4709 (3.511)	.4209 (3.024)
IQ	-.02773 (-3.104)	-.02739 (-3.068)	-.02941 (-3.269)	-.02918 (-3.225)	-.02808 (-3.111)	-.03071 (-3.411)	-.02809 (-3.118)	-.02872 (-3.196)	-.02804 (-3.127)	-.02727 (-3.023)
Years of education	.04924 (5.870)	.04971 (5.929)	.04754 (5.744)	.04771 (5.774)	.04842 (5.803)	.04651 (5.591)	.04847 (5.799)	.04796 (5.729)	.04856 (5.822)	.05189 (5.508)
Quality	-.0001221 (-.8624)	-.0001598 (-1.160)	.00009086 (.3376)	.00004666 (.1712)	-.0007974 (-.4251)	.002583 (1.082)	-.000004321 (-.4343)	-.000002625 (-.08214)	-.00001252 (-.5325)	-.00001189 (-.8829)
R^2	.02551	.02590	.02510	.02505	.02515	.02579	.02515	.02503	.02521	.02553
Quality mean	518.973	537.691	555.328	576.747	58.0729	59.776	10331.5	1150.03	1874.95	2277.32

educated person is investing further by giving up income to acquire on-the job-training. Here it appears the more educated earn more in the first year.

The IQ variable now becomes significantly negative, perhaps indicating a tendency for those more able to invest more in on-the-job training in initial years in the labor force. Finally, schooling quality has an insifnificant effect.

It is apparent that the importance of college quality grows with experience in the labor force. One reason might be that students in better colleges are better prepared to benefit from on-the-job training in their post-school lives.

VII. Conclusion

Two distinct dimensions of college quality have been identified; namely, peer group effects, measured by average S.A.T. scores of entering freshmen at a college, and faculty quality, measured by average faculty salaries. The average rate of return twenty years later to investments in college quality appears to be very high. Moreover, it seems that quality of college(s) attended yields increasing payoffs as time in the labor force gets longer; that is, the income elasticity of quality is not statistically significant in the initial year of employment and is greater after twenty years than after seven years.

College quality appears to have a greater impact on incomes for high ability students than for low ability students. This was seen by larger quality elasticities when the earnings functions were estimated for the top half of the sample in terms of IQ compared to estimates for the lower half and when the sample was divided into quartiles. Also, the multiplicative interaction terms for quality and IQ were positive and at times nearly significant statistically. Quality differences also seem to matter more among poor colleges than among good colleges. There also seems to be a negative relationship between the effects of college quality and years of education attained in terms of future earning power except for those individuals at the top of the ability distribution. It appears, from this preliminary examination, that two general observations can be made. First, individual ability complements college quality; and second, additional years in school are substitutes for college quality in the process of preparing to earn income in post-school life.

This research has been suggestive of further work on the question of impact of college quality. The impact of quality of each level of college on groups classified by different levels of attainment (years) should be looked at. A more detailed analysis of the effects of quality at different points in the life-cycle would be worthwhile. Finally, it is highly desirable that a more general data set be developed so that college quality's impact on the less able and on blacks could be studied.